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EXPERIMENTS IN DUSTING VERSUS SPRAYING ON APPLES AND PEACHES IN CONNECTICUT IN 1921.

By W. E. Britton, M. P. Zappe and E. M. Stoddard.

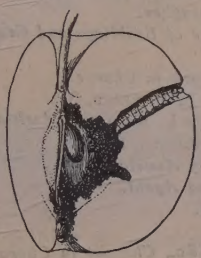

Figure 7. Apple Worm or Codling Moth.

Figure 8. Brown Rot of Peach.

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February, 1922.

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Experiments in Dusting versus Spraying on Apples and Peaches in Connecticut in 1921.

By W. E. Britton, M. P. Zappe and E. M. Stoddard.*

The series of experiments with dusts in comparison with liquid sprays for controlling the common insect and fungous pests of apple orchards in Connecticut, was begun in 1920, and the results printed in the Report of this Station for that year, pages 168-177. This project, considerably enlarged and including peaches, was continued in 1921. In 1920 the tests were all made in one orchard, while in 1921, experiments were conducted in four apple orchards and two peach orchards, as follows:—

APPLE ORCHARDS.

Orchard No.	I.	Young orchard, Station Farm, Mount Carmel	96 trees
" "	II.	Orchard of W. F. Platt, Orange	97 "
" "	III.	Orchard of F. N. Platt, Milford	524 "
		Old orchard, Station Farm, Mount Carmel ..	40 "
			757 trees

PEACH ORCHARDS.

Station peach orchard, Mount Carmel	150 trees
Peach orchard of M. L. Coleman, Cheshire	113 "
	263 trees

Originally it was planned to use only the first two apple orchards and the peach orchards, but later we were offered the use of the third apple orchard. We desire to express our appreciation and thanks to the owners of orchards No. II and III and to Messrs. M. L. and Raymond Coleman for their co-operation in this work; also to Mr. B. A. Porter in charge of the Wallingford field station of the Bureau of Entomology, for the use of the dusting machine, and for aiding us in making some of the applications, and in scoring the fruit. Mr. George E. Graham of the botanical department of this Station assisted in applying some of the treatments, and Messrs. B. H. Walden and Philip Garman of the entomological department, and F. D. Luddington, E. R. Barton, R. C. Botsford and J. R. Pedersen, temporary employees, aided in gathering and scoring the fruit.

The owners of the orchards furnished spray outfits with team and driver for each of the spray applications in orchards II and III.

* The planning of these experiments and the preparation of this paper are the joint work of the writers. The applications were made by Messrs. Zappe and Stoddard, who also supervised and took part in the harvesting and scoring of the fruit.

Apples.

MATERIALS USED.

Sprays:—

The liquid spray for all treatments in each of the three apple orchards was made as follows:—

Liquid lime-sulphur	3 gallons
Lead arsenate (dry)	3 pounds
Nicotine sulphate (Black Leaf 40)	¾ pint
Water	100 gallons

Dusts:—

SULPHUR-LEAD DUST.

Powdered sulphur	90 parts
Lead arsenate (dry)	10 parts

This dust was used only in the eastern part of orchard No. III, and as no treatment was given until after the bloom was over and as aphids and red bugs were rather scarce, the nicotine was omitted.

SULPHUR-LEAD-NICOTINE DUST.

Powdered sulphur	90 parts
Lead arsenate (dry)	10 parts
Nicotine sulphate (Black Leaf 40)	1 per cent.

This dust was purchased and should have contained one per cent. nicotine sulphate. During the course of making the applications, there seemed to be considerable difference in the color and odor of the material in some of the containers. Assuming that this might mean a difference in nicotine content, samples were submitted for analysis to Dr. E. M. Bailey of the chemical department, who reported them as follows:

Sample	Nicotine
No. 1	.29 per cent.
" 2	.30 " "
" 3	.84 " "
" 4	.71 " "

It will be noticed that none of these samples contained the full amount of one per cent. of nicotine. As it happened, red bugs, aphids, and leafhoppers were not seriously abundant in any of the orchards where this dust was used.

SANDERS DUST.

Hydrated lime	86 parts
Dehydrated copper sulphate	10 "
Calcium arsenate	4 "

This dust was used only in orchard No. III for the purpose of comparing it with the sulphur-lead dust.

Cost of Dust Mixtures.

The 1921 prices for the dust mixtures were as follows:

Sulphur lead dust and nicotine	$13.50 per hundred
Sulphur lead dust without nicotine ...	8.50 " "
Sanders dust	8.00 " "

In the dusting operations, between three and four pounds of dust were used per tree for each treatment. The cost of dusting an orchard at the present price of materials is about three times as great as spraying even though the time required to apply the dust is very much less than the time required to spray. If the price of farm labor drops it will mean a still greater saving in favor of the liquid spray.

Apparatus Used.

The dusting machine used in all three orchards was a Niagara duster owned by the Federal Bureau of Entomology, and used at its field station in Wallingford. The machine was constructed to be drawn by a team of horses, but this method was too slow when moving the outfit from orchard to orchard, so the machine was mounted on a Ford ton-truck, thus saving considerable time on the road and in the orchard. The Ford truck had no trouble in pulling this outfit through the orchards (see Plate XIX, a). When the machine was not in use it could easily be unloaded from the truck and stored in a shed.

An Arlington X. L. gasoline power sprayer was used for applying the liquid spray in orchard No. I. This was a new outfit, and the pressure was not very high, running at about 100 lbs. most of the time. Two lines of hose were used with a single nozzle on each rod.

In orchard No. II, the liquid spray was applied with a Friend gasoline power sprayer equipped with a tank holding 150 gallons. Two spray rods were used with two nozzles on each rod, and carrying a pressure of about 200 lbs. One man sprayed from the ground and another sprayed from a tower on the spray rig.

The spray outfit used in orchard No. III was identical with that employed in orchard No. II, except that instead of two lines of hose with double nozzles, a single line of hose with a "spray-gun" was used. The pressure was about 175 lbs., which is about as high as can be used without danger of mechanical injury to the foliage.

Number and Dates of Applications.

Two treatments after blossoming were given in each of the three orchards.

Orchard No. I had a delayed dormant spray of lime-sulphur on April 7. On April 21, the pink treatment of spray and dust was

applied. The calyx treatment was given on May 18 and 19 and the next or young fruit treatment was made on June 20.

Orchard No. 11 had a dormant spray of miscible oil applied by the owner. The pink treatment was given April 22. The calyx treatment was made May 16, and the next or young fruit treatment was given on June 13.

In orchard No. III, no dormant treatment was given by the owner, and no pink treatment was made, as it was too late before the orchard was offered to us for experiment. The calyx treatment was applied on May 16 and 17, and the next application or young fruit treatment was given on June 14, 15 and 16.

Method of Recording Data.

Certain trees promising a crop and situated inside the border of each plot, and representing the chief varieties upon which the tests were made in each orchard, were selected and marked as count trees. In orchard No. I, all trees were used as count trees in obtaining data. In orchard No. II, count trees were as follows:—8 sprayed, 6 dusted, and 7 checks. In orchard No. III, the following number were used as count trees:—12 sprayed, 12 sulphur-lead-nicotine dust, 8 Sanders dust, and 7 checks. For the sulphur-lead-no nicotine treatment, 2 Baldwin trees were used and a composite sample of Greenings from several trees because the crop on this variety was very light. As a rule the count trees were selected near the center of each plot and not adjacent to a plot having a different treatment, on account of the danger of spray or dust getting on to trees that were not intended to be so treated. With the liquid spray there is little danger of this, but the dust is quite apt to drift or be blown upon adjoining trees.

The green dropped fruit from each of the count trees was gathered, counted and examined for insect and fungous injuries, and the data recorded for each tree, at three different times during the season, as follows: July 11 and 12, July 25 and 26, and August 8 and 9. At harvest time the picked fruit was scored in the same manner. Each individual apple was carefully examined and a record made of each insect and fungous injury. Apples that were called "good" were absolutely free from any signs of insects or fungous diseases and might better be called "perfect" for they were free from pests and were perfect except possibly as to size. An apple showing the work of more than one pest would be checked as many times as there were kinds of insect injury or fungous diseases. This very often gave a greater number of injuries than there were apples and in order to get the true amount of any kind of injury all the apples had to be counted, and this number used to compute the percentage of injury or the percentage of good fruit. This scoring of the fruit involved examin-

ing separately 150,296 individual apples, equivalent to about 334 barrels.

The figures given in the tables of results from the various plots are percentages of perfect fruit or of injuries even if very slight, and cannot be compared with any commercial grading. For instance an apple that had been bitten by a curculio might only have one or two small blemishes and would be counted as a "curculio" apple, but in a commercial grading of the fruit would easily go as a No. 1 apple. The same is true of other injuries, especially small spots of scab, sooty blotch or fruit speck. After scoring the apples by the above method, all the fruit on several trees was graded as it would be for market. The results obtained by the commercial grading method are of the greatest importance to the fruit grower, and tell at a glance which treatment gives the highest per cent. of No. 1 fruit. See Plates XVII and XVIII. The other method of scoring is of value in showing just where certain treatments fail.

The following table has been prepared to show how the different treatments compare by both methods of recording data.

SCORING FOR INJURIES VERSUS COMMERCIAL GRADING.

	SCORING APPLES SINGLY					COMMERCIAL GRADING		
Tree	Good Per Cent.	Codling Moth Per Cent.	Curculio Per Cent.	Other Insects Per Cent.	Fungous Diseases Per Cent.	No. I Per Cent.	No. II Per Cent.	Culls Per Cent.
O1 Sprayed	48.4	.4	42.4	10.4	5.6	82.	15.8	2.2
B7 Nicotine Dust	4.95	.89	24.9	21.1	83.6	46.25	46.25	7.5
B11 Sanders Dust	.99	.43	20.8	18.1	97.5	60.7	32.7	6.6
B15 & C16 Check	0	8.43	32.8	21.5	97.7	20.	60.	20.
D8 Sprayed	33.2	1.46	58.5	9.9	4.38	83.	14.2	2.8
D14 Nicotine Dust	20.2	6.81	61.4	12.1	33.05	66.3	22.1	11.6
D9 Check	0	19.09	73.9	12.6	100.	11.1	33.3	55.6

ORCHARD NO. I.

Orchard No. I was the ten year old Experiment Station orchard located at Mount Carmel. This orchard is just beginning to bear, and consists of 96 trees on a side hill sloping to the west. All trees bearing fruit were used as count trees to check up results. The varieties were Baldwin, Rhode Island Greening, Roxbury Russet, McIntosh, Gravenstein, Duchess of Oldenburg, Fall Pippin, Northern Spy, Sutton Beauty, King, Wealthy, Hurlbut and Stark.

This orchard was divided into three plots. The north plot was treated with liquid spray and the south plot with the 90-10 nicotine dust. The remaining plot in the center of the orchard was used as a check.

NUMBER AND DATES OF APPLICATION.

The spraying and dusting in each orchard was usually done on the same day or on the following day if there was not time enough to finish the work on the first day.

Before the dusting operations began this orchard had a delayed dormant spraying of lime-sulphur on April 7 over the entire orchard. The pink spray was applied on April 21. The weather conditions were very favorable for dusting and spraying on this day, there being a very light breeze from the southeast. The dust flowed very freely and drifted through the orchard for quite a distance.

The calyx treatment was applied on May 18 and 19. The spray was put on in the afternoon of May 18, the dust on the morning of the 19th. The third treatment or young fruit spray was applied on June 20th. At this time there was no wind and the dust could be blown in almost any direction and would hang in the orchard like a fog.

RESULTS OF SPRAYING AND DUSTING.

	Good Per Cent.	Red Bug Per Cent.	Aphis Per Cent.	Curculio Per Cent.	Codling Moth Per Cent.	Other Chewing Insects Per Cent.	Scab Per Cent.	Sooty Blotch Per Cent.	Fruit Speck Per Cent.
Spray	39.9	.02	1.	48.2	5.78	10.5	1.28	1.7	.27
Dust	32.5	.00	.99	55.4	6.48	7.2	7.39	1.39	1.40
Check	24.8	.078	1.09	55.6	22.0	10.5	12.3	15.7	18.0

DISCUSSION OF RESULTS.

The liquid spray gave a higher percentage of good fruit than the dust, and the dust gave more good fruit than where no treatment was applied. With curculio and codling moth the spray gave better control, while with the other chewing insects the dust was a little better and for some unaccountable reason the spray and check plots gave the same result. The amount of aphis and red bug injury was so small that the figures are of no particular value. In the control of the fungous diseases, the spray was of more value than the dust, but the dust was much better than the check.

Orchard No. II.

This is the same orchard and some of the same plots of trees that were used in the season of 1920. The orchard is about 27 years old and has been very well kept. The varieties in the experimental plots were Greening and McIntosh, Fall Pippin and one tree of Hurlbut. The crop was very light this year.

There were 97 trees under experiment, 39 in the spray plot, 49 in the dusted plot and 9 in the check.

TIME OF APPLICATIONS.

The entire orchard had a dormant spray of oil which was applied by the owner. The pink spray was applied on April 22 and the first dust treatment was also applied on this date. The calyx treatment was made on May 16, both liquid and dust being applied on this day. On June 13, another treatment was given.

In this orchard fruit was picked and scored from 21 trees, with the following result:

RESULTS OF SPRAYING AND DUSTING.

	Good Per Cent.	Red Bug Per Cent.	Aphis Per Cent.	Curculio Per Cent.	Codling Moth Per Cent.	Other Chewing Insects Per Cent.	Scab Per Cent.	Sooty Blotch Per Cent.
Spray	48.2	.04	.02	14.7	1.9	4.5	33.3	.04
Dust	19.8	.78	.56	14.3	2.4	5.3	70.	3.25
Check	1.57	9.7	.68	43.7	12.3	11.7	76.	66.5

DISCUSSION OF RESULTS.

As far as the insects are concerned in this orchard, there is not much difference between the dust and the liquid spray. The liquid spray gave over twice the percentage of good fruit that the dust produced, which difference was largely due to the number of scabby apples in the dust treatment. In this orchard neither the spray nor the dust were very effective in controlling scab, due to the fact that the pink treatment was delayed too long on account of inclement weather.

Orchard No. III.

This orchard is located about two miles north of the village of Milford and is divided by a highway running north and south through it. The trees are about 17 years old and are on a fairly level piece of land with woods on two sides. The trees had dense crowns making it rather difficult to reach the centers with spray or dust.

The varieties in this orchard are Baldwin, Greening, Gravenstein, McIntosh and Hurlbut. This orchard had no dormant spray, and afterwards had one treatment less than the others, the pink spray being omitted.

TIME OF APPLICATION.

The first treatment was made at the time the petals had all dropped, on May 16 and 17. The second application was given on June 14, 15 and 16. The wind on these days was very strong and the dusting work was delayed a little on this account.

RESULTS OF SPRAYING AND DUSTING.

	Good Per Cent.	Red Bug Per Cent.	Aphis Per Cent.	Curculio Per Cent.	Codling Moth Per Cent.	Other Chewing Insects Per Cent.	Scab Per Cent.	Sooty Blotch Per Cent.	Fruit Speck Per Cent.
Spray	44.7	5.47	1.18	33.9	5.98	5.98	4.97	3.36	3.28
Sulphur Dust	27.4	3.72	.647	24.3	1.85	6.72	2.08	34.10	38.40
Nicotine Dust	22.6	12.37	.706	40.9	3.63	9.43	10.56	14.83	19.70
Sanders Dust	16.9	8.17	2.03	36.3	10.91	11.13	13.13	33.69	40.70
Check	4.6	16.70	1.24	60.1	26.73	30.09	34.98	29.87	35.25

DISCUSSION OF RESULTS.

As in the other orchards the spray is again better than any kind of dust. There are no striking differences in the results between the three kinds of dust used. The figures show less scab when sulphur dust was used, but the varieties in this particular plot, Baldwins and Greenings, are not ordinarily very susceptible to scab, especially Baldwins. All kinds of dust were less effective than the spray in controlling the fungous diseases.

Comparison of Different Sprays.

In addition to the work on the comparison of dusting and spraying, an experiment was conducted on an orchard of 40 forty-five-year old Baldwin and Greening trees at the Station Farm in Mount Carmel in which four different sprays were compared. This experiment has been conducted for three years, but as the 1921 results are representative of the two previous season's results, only the work and results of this season will be discussed.

MATERIALS USED.

The sprays used in this experiment were liquid lime-sulphur, dry lime-sulphur, B. T. S., and Bordeaux mixture.

LIQUID LIME-SULPHUR.

Lime-sulphur	1½ gallons
Lead arsenate (powder)	1½ pounds
Water	50 gallons

DRY LIME-SULPHUR.

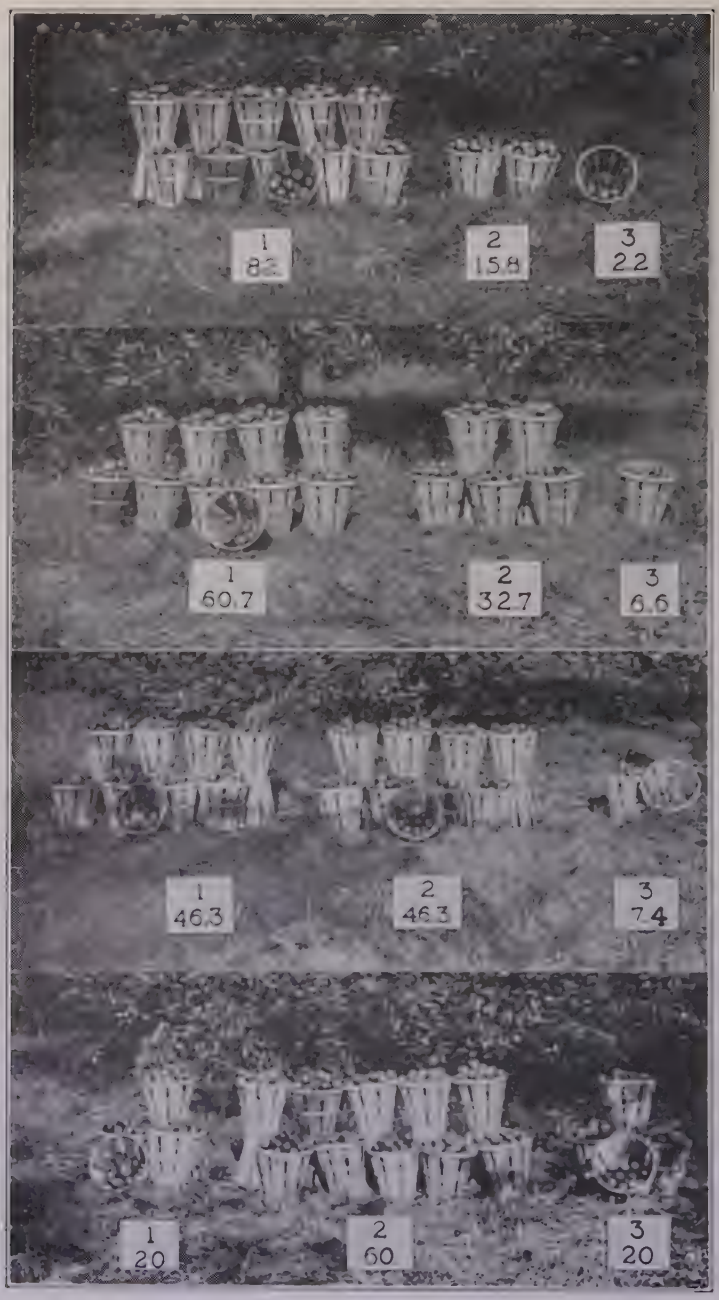
Dry lime-sulphur	3 pounds
Lead arsenate (powder)	1½ pounds
Water	50 gallons

B. T. S.

B. T. S.	1½ pounds
Lead arsenate (powder)	1½ pounds
Lime	3 to 4 pounds
Water	50 gallons

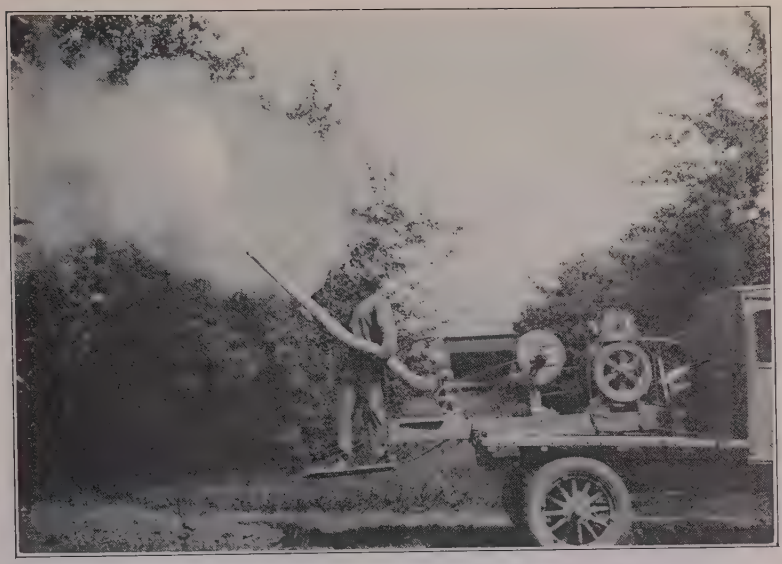
Harvested fruit from orchard No. I. Sprayed fruit at top, dusted fruit in center, and check or untreated fruit at bottom. The percentage of fruit in each grade is shown on the labels.

COMMERCIAL GRADING OF APPLES FROM EXPERIMENT PLOTS.



Harvested fruit from orchard No. III. Sprayed fruit at top, Sander's dust in second view, sulphur-lead-nicotine dust in third view, and check or untreated fruit at bottom. The percentage of fruit in each grade is shown on the labels.

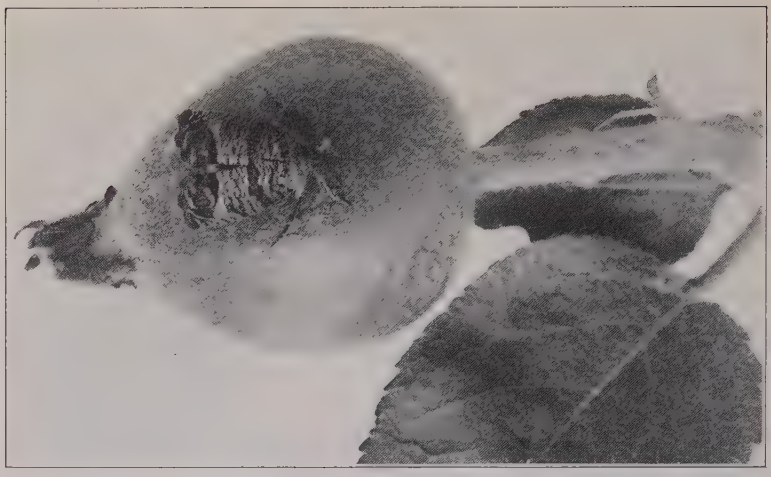
COMMERCIAL GRADING OF APPLES FROM EXPERIMENT PLOTS.



a. Dusting outfit used in experiments.

b. Spraying outfit used in orchard No. II.

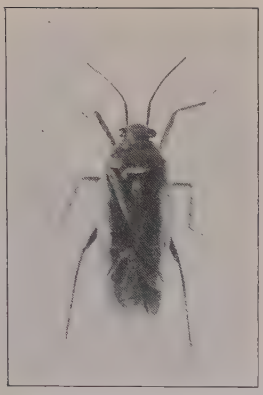
DUSTING AND SPRAYING IN APPLE ORCHARD.



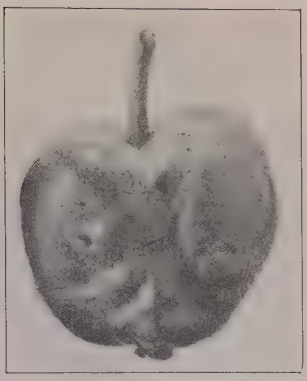
a. Adult moth resting on young apple, twice enlarged.

b. Stem, calyx and side injury: section of fruit showing larva in burrow. Natural size.

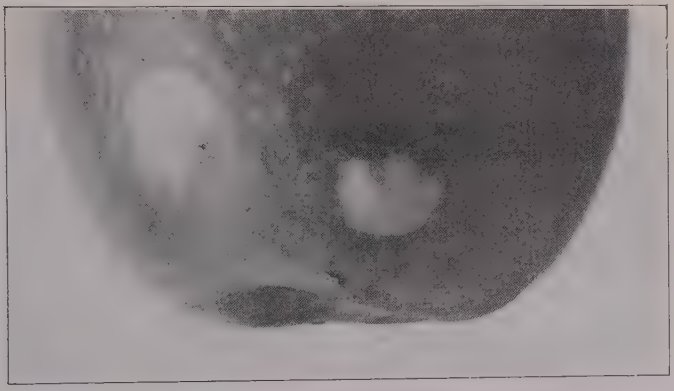
CODLING MOTH.



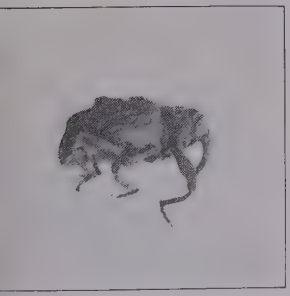
a. Adult red bug. Four times enlarged.



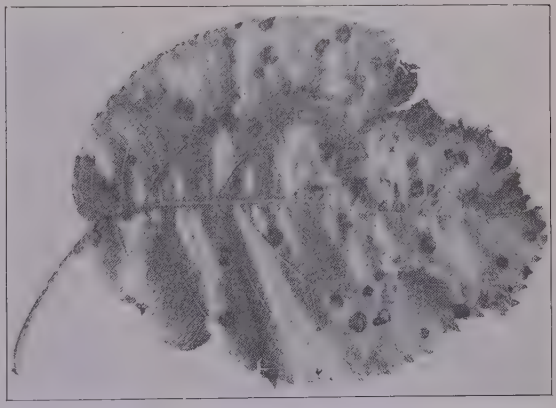
b. Apple injured by red bugs. Natural size.



c. Curculio egg-scars as they appear at harvest time. Natural size.



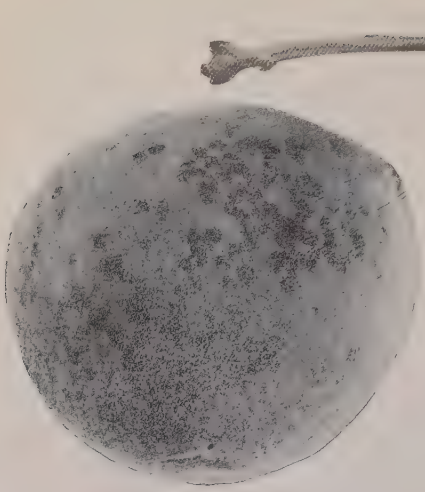
d. Plum curculio side view. Four times enlarged.



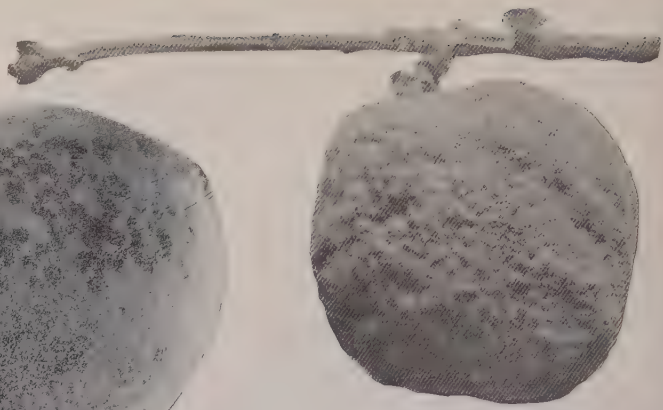
e. Spots on apple leaf caused by black rot fungus. Natural size.

RED BUG, CURCULIO AND BLACK ROT.

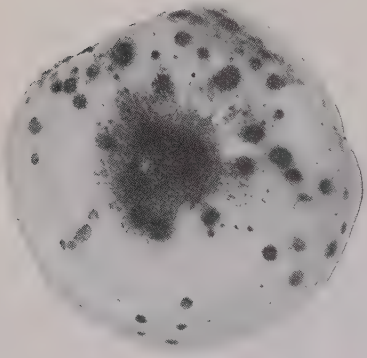
PLATE XXII.



a. Peach Scab.

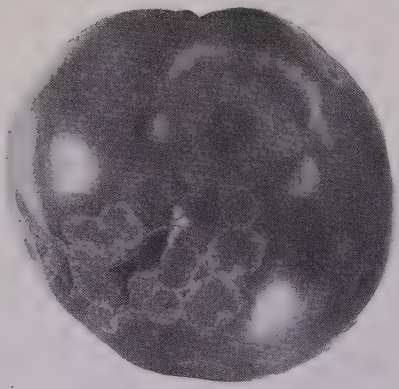


b. Brown rot of peach.

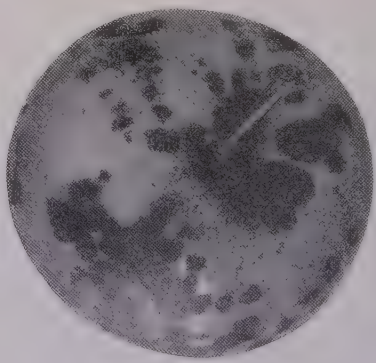


c. Fruit speck of apple.

d. Black rot of apple.



e. Apple scab.



f. Sooty blotch of apple.

FUNGOUS DISEASES OF PEACH AND APPLE.

BORDEAUX MIXTURE.

Copper sulphate	1 pound
Lime	4 pounds
Lead arsenate (powder)	1½ pounds
Water	50 gallons

APPARATUS USED.

All the applications were made with an Arlington X. L. outfit, using two lines of hose and rods with one Friend nozzle to each rod. This outfit maintained a pressure of 125 pounds.

DATES OF APPLICATION.

The entire orchard had a delayed dormant spray of lime-sulphur 1-9 on April 7. As scab was known not to be abundant in this orchard, the pink spray was omitted. The calyx spray was put on May 19 and the young fruit spray on June 20.

The following table shows the results obtained.

RESULTS OF SPRAYS.

	Good Per Cent.	Red Bug Per Cent.	Aphis Per Cent.	Curculio Per Cent.	Codling Moth Per Cent.	Other Chewing Insects Per Cent.	Scab Per Cent.	Sooty Blotch Per Cent.	Fruit Speck Per Cent.
Dry Lime-Sulphur	72.5	.13	1.24	10.70	.66	8.7	.03	8.42	3.64
Liquid Lime-Sulphur	53.6	.14	1.67	21.76	5.43	17.70	.66	5.24	2.66
B. T. S.	54.2	.34	3.09	22.92	4.92	11.64	.34	13.24	4.57
Bordeaux	52.0	.25	1.8	23.82	8.29	11.85	1.78	9.08	3.86

DISCUSSION OF RESULTS.

In this experiment the dropped fruit was not scored and records were made from harvested fruit from all trees, otherwise the data was taken as described elsewhere in this paper. The check trees did not bear any fruit so no comparison could be made with untreated trees. It will be seen that the dry lime-sulphur gave the highest per cent. of good fruit, this also being true in the two previous seasons' work with this material. Not only was there a higher per cent. of good fruit but the appearance and finish of the fruit was superior to that from the other plots. The B. T. S. gave about the same control of fungous and insect pests as did the lime-sulphur but the fact that it caused considerable injury to the foliage makes it an undesirable material to use. It was estimated that it caused a drop of from 30 to 40 per cent. of the foliage, as compared with no injury from any of the other treatments.

Usually there has been considerable russetting of the fruit on the Bordeaux plot and probably this year was no exception, but on account of the fact that late frosts caused more or less russetting of the fruit on all of the plots, it was not possible to get any data on this point. Because of its tendency to russet the fruit, we do not recommend Bordeaux as a spray for apples.

Chief Pests Attacking the Fruit of Apple Orchards.

INSECTS.

Codling Moth:—This is the chief insect attacking apple orchards and though varying in abundance is present every year in every orchard. It passes the winter as a larva in the cocoon, transforming to a pupa in the spring. The moths emerge soon after the trees blossom and lay their eggs chiefly on the leaves, though sometimes on branches and developing fruit. The egg-laying period extends over several weeks, and in about a week these eggs hatch, and the larvae feed slightly on the foliage but tunnel into the fruit mostly through the calyx. They eat their way to the core, and later burrow to the surface making the traditional worm hole, as shown on Plate XX, b. From 20 to 30 days are required for larval development, when the worms leave the fruit usually before it falls, and seek a protected place to spin the silken case or cocoon. Of those assuming this stage in mid-

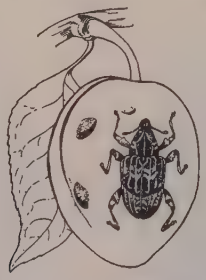


Figure 9. The Plum Curculio.

summer, a portion transform the same season, while those going into their cocoons late in summer or autumn do not emerge as adults until the following season. There is usually one full generation, and a partial second each year in Connecticut.

The codling moth is usually less injurious in orchards which are sprayed each year with arsenical poisons.

Plum Curculio:—The adult is a weevil or snout beetle which hibernates in rubbish heaps, hedgerows, woodlands, *et cætera,* where it can find protection. It appears on trees soon after the buds open, and soon after the fruit sets and the petals drop begins to puncture the young fruit. Two kinds of punctures are made, one for feeding and the other for depositing eggs. The latter are crescent-shaped and the egg is placed just under the skin of the flap on the concave side of the crescent. Egg-laying may extend over nearly the whole season, though most of them are laid during the first month after the blossoms fall. The feeding punctures are small cavities eaten into the surface of the fruit and usually occur in clusters. They may be made late in the season. There is only one generation each year, and this insect usually breeds in

stone fruits. The larvae do not develop in the apple, and the only injury is that caused by the punctures. Plate XXI, c, shows the egg-scars as they appear on the fruit at harvest time. The application of poisons, though of some benefit, is not a satisfactory control for this insect. Much more can be accomplished by abolishing its hibernating places, like rubbish heaps, hedgerows, *et cætera,* in or near the orchard.

Other Chewing Insects:—Many insects might be included under this head, but only a few will be mentioned in connection with the orchards where our experiments were conducted.

Apple Maggot:—This was not a serious pest in these orchards, though present and causing some injury on certain varieties. Later treatments, so that the foliage and fruit will be coated with poison during July, may be effective in poisoning the adults before they lay eggs.

Leaf-Rollers:—In 1920, there was considerable surface injury to fruit late in the season caused by the red banded leaf-roller *Eulia velutinana* Walker, and the lesser apple worm *Enarmonia prunivora* Walsh. Consequently some later treatments were given a portion of some of the plots, but these insects were not noticed in 1921, and the treatments gave no benefit.

Aphids:—The green apple aphid *Aphis pomi* DeGeer, and the rosy aphid *Anuraphis malifoliae* Fitch (*Aphis sorbi* Kalt.) were not prevalent in the experiment orchards in 1921. Some eggs hatched, but the aphids soon disappeared, perhaps on account of cold storms, lady beetles, or other natural agencies, and caused no appreciable injury. For this reason no marked benefit can be shown by the treatment against these insects. The eggs hatch at about the time that the leaf buds begin to unfold. Nicotine sulphate in the delayed dormant, pink and calyx treatments should control these aphids.

Red Bug:—The false apple red bug *Lygidea mendax* Reut. was not abundant in any of the experiment orchards in 1921, but was more prevalent in orchard No. III than elsewhere. Here and also in orchard No. II the check plots showed much more injury than the treated ones. The eggs hatch just before the blossoms open and nicotine sulphate in the pink treatment and in the calyx treatment, if thoroughly applied, should kill most of the nymphs.

Fungous Diseases.

Scab:—Scab was very prevalent during the past season in most orchards. This can probably be accounted for in two ways; first, the mild winter, which allowed the fungus to carry over in good condition on the old leaves and mature a large crop of spores which infected the young foliage early in the spring, and second the fact that there was a rainy spell which was most favorable for

scab infection and which prevented putting on the pink spray at the proper time. Under Connecticut conditions the pink spray is the important spray for scab control and on varieties which are particularly susceptible it would seem desirable to put on two sprays after the leaves come out and before the blossoms open. It seems to be the consensus of opinion among plant pathologists that it is not feasible to attempt to treat or destroy the leaves under the trees, on which the scab carries over winter, but rather to control it by proper and timely spraying. See Plate XXII, e.

Black Rot:—Black rot was more prevalent, especially on the foliage, during 1921 than usual. This disease was present to a greater or less extent in all the orchards which were observed during the season and probably these represent a general condition throughout the State. Usually Baldwin was the variety most susceptible, although other varieties showed some infection. In one orchard only was any serious damage done and in this only a small number of trees were severely attacked.

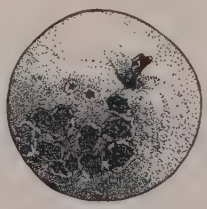


Figure 10. Apple Scab.

On the leaf the black rot fungus makes small dark brown circular spots and later causes the leaf to turn yellow and drop prematurely. This fungus also attacks the fruit, making a brown rotting of the flesh of the apple, which form of infection was noted in a few cases, but nowhere did any serious damage result. The Hurlbut seemed to be more susceptible to fruit infection.

This fungus does not usually do any great amount of damage in Connecticut and if present should be controlled by the ordinary spraying schedule. The infection on the foliage evidently takes place early in the season, making the pink spray important in its control. This fungus is shown on the leaf on Plate XXI, e, and on the fruit on Plate XXII, d.

Fruit Speck:—Fruit speck or "Brook's spot" is a fruit disease and causes the very small irregular black spots on the skin of the apple which on light skinned varieties are usually bordered with red, the spots occurring most abundantly near the calyx end. This disease should not be confused with "Baldwin spot" which is a physiological trouble characterized by brown corky spots

scattered through the tissue of the fruit. Fruit speck, being a fungous disease, can be controlled by spraying with a fungicide while the "Baldwin spot" is not affected by such applications. To control fruit speck successfully, the spraying should be done very thoroughly. The fruit speck fungus does not injure the quality of the fruit but spoils its appearance, and makes an entrance for various decay organisms.

Figure 11. Sooty Blotch of Apple.

Sooty Blotch:—This disease is one of the most common apple diseases and is probably one of the easiest to control by spraying, yet it seems to be true that less attention is paid to it than to other troubles, for instance, a grower will be much alarmed at a heavy scab infection but will almost consider sooty blotch a necessary adjunct to the finish of his fruit. The sooty blotch fungus grows entirely on the skin of the apple and does no harm except to injure its appearance seriously, as is shown on Plate XXII, f.

PEACHES.

In addition to the experiments with dusts and sprays in apple orchards, experiments were conducted to test the comparative values of dusting and spraying on peaches. Two orchards were used, one at Mount Carmel owned by this Station, and the other in Cheshire, owned by Mr. M. L. Coleman.

Apparatus and Materials Used.

In the spraying of both orchards, an Arlington X. L. power sprayer with a 100 gallon tank was used, carrying two lines of hose with one nozzle on each rod, at a pressure of about 125 pounds. The dusting machine used at Mount Carmel was a Niagara duster, being the same one that was used in the apple dusting experiments. The duster used at Cheshire belonged to Mr. Coleman, and was also a Niagara machine.

The spray material used in both orchards was atomic sulphur, at the rate of 10 pounds to 100 gallons of water. The dust used at Mount Carmel was ordinary dusting sulphur, and at Cheshire the dust used for the first two applications was a 70-20-10 mixture, 70 parts of sulphur, 20 parts of lime and 10 parts of lead arsenate. For the third dusting at Cheshire, the lead arsenate and lime were omitted.

Method of Recording Data.

In the peach experiments, the dropped fruit was not gathered and scored as was the case with the apples. No count trees were selected here, but a record taken from every tree which bore fruit. In harvesting, several pickings were made and each fruit examined and injuries recorded. This necessitated the examination of 120,063 individual fruits, or about 1,715 baskets.

Mount Carmel Orchard.

This orchard is ten years old, planted on the brow of a hill sloping toward the west, and comprises 150 trees planted in five rows of 30 trees each. The varieties which were used in this orchard are Elberta, Carman, Champion, Mountain Rose and Greensboro. The orchard was divided into three plots, the north plot was sprayed, the south plot dusted and the center plot left untreated for a check.

Three applications of spray and dust were made in this orchard, the first on May 18th when the "shucks" had all dropped from the young fruit; the second on June 16th and the last on July 13th and 14th. The dust used was the regular dusting sulphur with no lead arsenate or lime added. The liquid spray used was atomic sulphur, 10 pounds to 100 gallons of water, with no lead arsenate. As no arsenical poison was used in this orchard, and as there was practically no scab, the only injuries recorded were those caused by brown rot.

RESULTS OF TREATMENT.

		Good Fruit Per Cent.	Rot Per Cent.
Elberta:			
	Spray	98.6	1.34
	Dust	99.6	.36
	Check	99.6	.38
Carman:			
	Spray	93.	7.2
	Dust	97.5	2.5
	Check	No Checks for this variety	
Champion:			
	Spray	89.3	10.7
	Dust	98.4	1.6
	Check	96.5	3.4
Mt. Rose:			
	Spray	88.2	11.8
	Dust	99.2	.88
	Check	98.5	1.6
Greensboro:			
	Spray	79.9	20.1
	Dust	87.5	12.7
	Check	No Checks for this variety	

Discussion of Results.

On all varieties the dust was more effective in controlling brown rot than the spray. The amount of scab and curculio injury was so slight that no data was taken. The check trees in this orchard had better fruit than the sprayed trees because the trees were close together and the check trees were north of the dusted plot and at every application of dust the wind was from the south or southwest, thus blowing the dust onto the check trees.

Cheshire Orchard.

This orchard is about the same age as the Mount Carmel peach orchard. Because of the size of the orchard, only a portion containing two varieties, Carman and Elberta, was used in the spraying and dusting tests. Mr. Coleman, the owner of the orchard, has been dusting peaches for several years with satisfactory results, and this year he dusted all of his orchard except that portion where the sprayed plot was located. The records of the dusting were taken from a portion of the orchard adjacent to the sprayed plot. A few trees on the edge of the orchard at the end of the sprayed plot were left without treatment as checks. One hundred and thirteen trees were included in the three plots.

This peach orchard, like the other, was given three treatments of spray and dust, on the following dates: May 22, June 18 and July 13. The spray used was atomic sulphur, 10 pounds to 100 gallons of water. No lead arsenate was used in the liquid spray.

The liquid spray was applied with the same outfit as was used at Mount Carmel. The outfit was carried to Cheshire on a Ford truck to save time. On arriving at Cheshire the sprayer was unloaded and a horse used to draw it about the orchard, as the trees were too close to allow the truck to pass through the orchard. Five pickings were made of Carman, August 10, 12, 14, 16 and 19, and four of Elberta, September 2, 5, 7 and 9. There was considerable scab in this orchard, so records were made of light and heavy infestations of scab, together with rot and curculio.

RESULTS OF TREATMENT.

		Good Per Cent.	Rot Per Cent.	Light Scab Per Cent.	Heavy Scab Per Cent.	Curculio Per Cent.
Elberta:						
	Spray	65.	2.66	27.39	1.2	5.52
	Dust	69.9	5.24	22.4	.94	3.24
	Check	17.4	5.81	58.4	17.6	2.91
Carman:						
	Spray	37.4	7.15	43.2	12.12	4.61
	Dust	56.	4.92	27.4	9.4	5.12
	Check	27.3	16.5	38.2	21.7	4.53

It will be noted that on both varieties the dust gave a higher percentage of good fruit than the spray, largely through the more effective control of rot and scab. The lead arsenate in the dust did not control curculio to any appreciable extent. For some unknown reason the curculio injury was less in the check plot in both varieties than in either the dusted or sprayed plot. Peaches scored as "light scab" had only a small amount of scab, and would be graded as No. I. Those scored "heavy scab" would not be included in a No. I grade. Most of the peaches in the curculio column would undoubtedly be included in a No. I grade.

Cost of Dusting and Spraying Peach Orchards.

The price of dusting sulphur without lead arsenate used for dusting the peach orchards was $3.75 per 100 pounds in 1921, and the cost of atomic sulphur in 100 pound lots was $12.75. Allowing one pound of dust and one gallon of spray per tree the cost is, dust 3¾ cents per tree, spray 1¼ cents per tree for one treatment only. There would be quite a saving of time in favor of the dust which would partly offset the higher cost of material and make the treatments more nearly equal in price. However, it is doubtful if it would pay to dust peaches unless a large acreage was to be treated so that enough time could be saved to make an appreciable cut in the labor cost. It would be necessary to have a spray outfit for the dormant treatment and the extra cost of the duster would probably not be offset by the saving of time and slightly better results on a small orchard.

Pests of the Fruit of Peach Orchards.

INSECTS.

Plum Curculio:—The curculio is unquestionably the most important insect attacking the fruit of the peach. This insect has already been discussed on page 218 as an apple pest. In the peach fruit, the larvae develop to maturity and transform. Most of the infested fruits drop early and therefore do not show at harvest time, though the egg-laying and feeding punctures are often apparent. Curculio can best be controlled by getting rid of all hibernating places near the orchard. Arsenical applications, though a help, should not be depended upon as the only means of control.

FUNGOUS DISEASES.

Brown Rot:—Brown rot is the most serious fungous disease that the peach grower has to contend with, but it can be controlled by thorough and timely treatment. Usually this is a disease of the fruit but under favorable conditions such as obtained in the spring of 1921, serious infection of the blossoms on early varieties is likely to take place. Such infection not only kills the blossom but forms a canker which often girdles and kills the entire branch.

The blossom and twig infection seems to be worst in orchards where spraying or dusting has not been regularly practiced, and there are large quantities of mummied fruits on the ground and in the trees to spread the disease early in the season.

Peach Scab:—Peach scab does the larger part of its damage on the fruit, but the fungus infects the twigs and leaves as well. It is from the twigs that the scab fungus is spread to the fruit by the spores falling and being washed onto them by rain. In this connection it is interesting to note that scab spots are always on the upper surface of the fruit. Like many fungous diseases an important factor in scab control is to prevent it from getting a start in the orchard. If an orchard is well sprayed or dusted from the start, scab probably will not be especially abundant.

Summary.

1. Dusting experiments in comparison with spraying were conducted in Connecticut in 1921 in four apple orchards containing 757 trees, and in two peach orchards containing 263 trees. This involved the scoring of 150,296 apples, equivalent to about 334 barrels, and 120,063 peaches, or about 1,715 baskets.
2. The dusts were all applied with Niagara dusting machines, and the sprays with Friend and Arlington X. L. power sprayers. In each case two treatments were given after blossoming on apples, and three treatments on peaches.
3. The dusts used in the apple orchards were the sulphur-lead dust, sulphur-lead-nicotine dust, and Sanders' dust. The liquid spray used for comparison in all apple orchards contained liquid lime-sulphur, lead arsenate and nicotine sulphate. In one orchard comparative tests were made between liquid lime-sulphur, dry lime-sulphur, B. T. S., and Bordeaux mixture, with lead arsenate added to each.
4. In nearly all cases the best apples were obtained from the sprayed plots. Both spray and dust gave fairly good control as regards codling moth, and other chewing insects; neither controlled curculio; the spray was more effective in controlling the fungous diseases. In the sprayed orchard dry lime-sulphur gave a larger percentage of good fruit than liquid lime-sulphur, B. T. S., or Bordeaux mixture.
5. The chief pests attacking the fruit in these apple orchards in 1921 were codling moth, plum curculio, apple maggot, various chewing insects, aphids, red bug, scab, black rot, fruit speck and sooty blotch.
6. On peaches the only spray was atomic sulphur, and the dusts were sulphur, and sulphur-lime-lead arsenate dust.
7. In all the peach orchards the dusted plots gave slightly better fruit than the sprayed plots. Peach scab and brown rot were controlled by both dust and spray.
8. The chief pests attacking the fruit in these peach orchards in 1921 were curculio, brown rot and peach scab.
9. At present dusting is more costly than spraying in both peach and apple orchards.